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Carrot Blight In Southwestern Ontario And The Importance Of Radiation And Temperature In The Sporulation Of Alternaria Dauci

Ramon Clemence Zimmer

THE INFLUENCE OF PERCENTAGE OF REWARD SHIFTS ON CHILDREN'S RESPONSE SPEEDS

by

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ABSTRACT

Forty male and 40 female Grade 1 children were administered 24 preshift and 24 postshift trials on a single-lever apparatus. Equal numbers of male and female Ss were randomly assigned to one of four groups. Two groups (50 - 50 and 100 - 100) received either continuous or random 50% reinforcement on all 48 trials. The other two groups (100 - 50 and 50 - 100) were shifted, after the 24 preshift trials, from partial to continuous reinforcement or vice versa. The response measures were the reaction, starting and movement speeds of the lever-pulls. The rewards were marbles which could be used to see coloured slides during intertrial intervals.

It was predicted that anticipatory frustration would develop as a result of nonreward and that this frustration would become conditioned to the instrumental lever-pulling response causing the partially rewarded groups to exhibit faster movement speeds over the preshift trials (Amsel, 1958, 1962). It was also hypothesized that the reward expectancy (defined as a function of the number of previously reinforced responses experienced) of Group 100 - 50 would be greater than that of Group 50 - 50 so that, during the postshift trials, the movement speeds of Group 100 - 50 would increase to a level above that of Group 50 - 50. A further prediction was that the movement speeds of Group 50 - 100 would decrease, relative to those of Group 50 - 50, because of the gradual extinction of the frustration mechanism $r_f - s_f$. No specific

predictions were made concerning reaction and starting speeds. The findings of the study are as follows:

(a) During the postshift phase, the reaction speeds of partially reinforced groups (i.e., 50 - 50 and 100 - 50) increased at a greater rate than those of the continuously reinforced groups (i.e., 100 - 100 and 50 - 100). There were no other significant differential effects of reward schedules or reward schedule shifts upon preshift and postshift reaction and starting speeds.

(b) The preshift movement speeds of partially rewarded groups increased at a significantly greater rate than those of the continuously rewarded groups. This difference was also found in the data for male Ss, as well as a significant main effect for reinforcement schedule with the partial reward groups responding faster.

(c) As predicted, during the postshift phase the movement speeds of Group 100 - 50 did increase rapidly as compared to Group 50 - 50. Those of Group 50 - 100 did decrease relative to those of Group 50 - 50. However, none of these effects were statistically significant. All the trends observed were more pronounced for male Ss and were also observed in the starting speed data.

Several factors were suggested as being likely causes for the large variability of response speeds and the subsequent nonsignificance of the effects of the reward schedule shifts. One of these was that the Ss might have been at a low level of motivation and that this motivation fluctuated during the experiment as a function of the different slides viewed as reinforcements. It was also proposed that the relatively long intertrial interval (about 25 secs.) allowed primary frustration due to nonreward to dissipate. Finally it was suggested that the Ss might have participated more actively if they had been asked to volunteer to take part in the experiment.

Some comments were made as to the adequacy of frustrative nonreward theory in accounting for behaviour which is rewarded discontinuously. The theory has met with difficulty in explaining data from research done with animals as well as that which has manipulated magnitude of reward with children. It was suggested that the results of the present study were not comforting to Amsel's frustration model and that reward expectancy in children might be more of an individual difference rather than a function of experimental variables. It was also proposed that the theory be tested in experimental situations involving more complex behaviour.

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INTRODUCTION

Amsel (1958, 1962) proposed a theory of frustrative nonreward which proved useful in predicting the behaviour of animals under conditions of noncontinuous reward (e.g., Amsel and Roussel, 1952). It has also recently provided the basis for a number of studies of the relationship between reward schedules and the response rates of normal and retarded children presented with a free-operant task (e.g., Bijou and Orlando, 1961; Long, 1963; Girardeau and Corte, 1965) or discreet trial situations involving a single instrumental response.

Previously, frustration had been regarded as resulting from the blocking of libidinal energy (Freud, 1957) or any goal-directed behaviour. It was thought of as producing regression (Mowrer, 1940) and aggression (Dollard, Doob, Miller, Mowrer, and Sears, 1939). Maier (1949) assumed frustration to result from confrontation with an insoluble problem and to be an emotional response to such a situation which reduced performance in some manner. The notion that frustration might also facilitate performance was first proposed by Child and Waterhouse (1952, 1953; Waterhouse and Child, 1953). The effects of frustration, they said, depended on whether or not the frustration-produced responses interfered with ongoing behaviour.

Amsel's (1958, 1962) proposal concerning frustration was placed in the framework of Clark Hull's (1943, 1952) theory of learning and it differed from others in that it was more amenable to experimental test. Only those features of the theory which are pertinent to a discussion of the relationship between reward expectancy and frustration will be reviewed here.

The theory as first presented by Amsel (1958) and later extended by Spence (1960), set frustration as an aversive emotional state resulting from nonreward when reward is expected. As an organism completes several rewarded instrumental responses, reward expectancy or anticipatory goal responses (r_g) become conditioned to, and are elicited by, stimulus cues earlier and earlier in the response sequence. Following this development of reward expectancy ($r_g - s_g$), nonreward will produce frustration and an increase in primary drive level. This increment is temporary but augments immediately following behaviour, producing the phenomenon termed by Amsel (1958) "the frustration effect."

If trials continue and responses are sometimes reinforced and sometimes not, anticipatory frustration ($r_f - s_f$) develops in a manner similar to the anticipatory goal response. The anticipatory frustration responses produce internal drive stimuli which, when they have been classically conditioned to components of the instrumental response, serve to direct behaviour.

Thus in the early stages of partial reinforcement training, the same sequence of external stimuli evoke r_g and r_f, resulting in an approach-avoidance conflict. However, over trials, the instrumental response is maintained because, once it has been completed, the result is either reward or removal from the conflict situation. In other words, making the instrumental response is sometimes rewarded while not responding is never rewarded.

Using this formulation, one can explain the PREE or partial reinforcement extinction effect (i.e., increased resistance to extinction following partial relative to continuous reward). For groups trained under partial reward conditions s_f has been conditioned to the instrumental response and, thus, these groups continue responding longer to continuous nonreward than groups trained under continuous reward conditions.

The FE or frustration effect has been demonstrated and can be predicted by Amsel's theory. Amsel and Roussel (1952) showed that the running speeds of rats in a second runway were faster following nonreward as compared to following reward for running in a first runway. This finding is expected because nonreward is assumed to produce an unlearned response (RF) to frustration which temporarily increases general drive level.

Amsel's theory also predicts the PRAE or partial reinforcement acquisition effect. In a review of the literature dealing with partial reinforcement, Jenkins and Stanley (1950) concluded that during acquisition, learning is more rapid and reaches a higher asymptotic level under continuous reinforcement than under partial reinforcement. Subsequently, however, Goodrich (1959) and Weinstock (1954) demonstrated an initial, inferior performance for partial reinforcement groups of rats. With extended numbers of trials, the partial reward groups reach a higher asymptotic level. These results are consistent with the proposal that a minimum amount of reward must be experienced (i.e., r_g must develop) before nonreinforcement is frustrative.

As previously mentioned, Amsel's theory of frustrative nonreward has recently been applied in research involving children in partial reinforcement situations. Penney (1960) studied the FE in children using a double-lever (R_1 and R_2) analogue of the double runway apparatus used in rat studies. Kindergarten children first pushed R_1 at the onset of a stimulus light and on rewarded trials a marble was ejected into a plastic tube. A second stimulus light signaled the pulling of R_2 which always led to a marble reward at a second goal box. The FE was revealed in that, for one of the experimental groups, response speeds on R_2 were faster following nonreward than following reward on R_1. Ryan (1963), however, argued that the results were an apparent FE due to the fact that speeds following reward were slower than speeds following nonreward.

Subsequent studies (Penney and Ryan, 1960; Ryan, 1965) failed to demonstrate an FE but Ryan and Moffitt (1966) employed a one-trial-a-day procedure rather than massed trials. Each trial consisted of one R_1 - - - R_2 sequence. The Ss were nursery school children. Group 40 received 40% reinforcement for R_1 responses and 100% reinforcement for R_2 responses. Group 100 was rewarded for all responses. Analyses of R_2 starting and movement speeds revealed a large FE in Group 40. It was concluded that in studies employing a massed trials procedure, Ss began each trial at an already high drive level because primary frustration perseverated from one trial to the next.

Bruning (1964) was able to demonstrate the PRAE using 64 kindergarten children who moved a lever in order to win candy. Half of the Ss were rewarded on a random 50% schedule and half received 100%

reinforcement. The movement speeds were significantly faster for partially as compared with continuously rewarded Ss. The same finding was obtained by Pederson (1967) where the 50% reward group received a valueless marble which could not be traded for a toy, on nonrewarded trials.

One of the variables involved in studies of frustration which has been relatively ignored is reward expectancy. Presumably if Ss have a high expectancy for reward, they will be more frustrated by nonreward and one would, therefore, expect a larger FE or PRAE. Reward expectancy, or the vigor of the $r_g - s_g$ mechanism (within Amsel's theoretical framework), is a function of the number of trials on which S responds and is reinforced. Although there is some relevant data among the literature, reward expectancy *per se* has not been systematically studied.

Ryan (1966) compared the response speeds of partial reward groups to those of a continuous reward group by dividing 108 preschool and kindergarten children into six reinforcement groups (100, 83, 66, 50, 33 and 17%). Over 54 trials, increasing speeds for the partial reward groups relative to those of the continuously rewarded group were found (PRAE). Asymptotic speeds were also shown to be an inverted U-shaped function of percentage of reinforcement, with intermediate percentages of reward producing fastest responding. These results can be explained in terms of frustration theory, as a high percentage of reward produces a high expectancy for reward but the few nonrewarded trials provide few frustrations. Conversely, the low percentage reward groups are frustrated often but have a low reward expectancy. Ryan (1966) noted that Group 17 movement speeds increased compared with Group 100 up to trial 30 and then gradually decreased. It was hypothesized that the instructions plus two reinforced practice trials were sufficient to lead these Ss to expect reward and that the frequent occurrence of nonreward early in training resulted in sufficient inhibition to reduce response speed.

Longstreth (1960, 1966) conditioned reward expectancy to a previously neutral cue and noted the effect upon extinction. In one study (1960), Grade 2 children held a lever down until a receptacle filled with marbles; in a second study (1966), kindergarten children turned a crank to win poker chips. For the experimental groups of both studies, a light was paired with the delivery of reward. For control Ss, the light was presented but not paired with reward. When the light was presented at certain times during extinction, the experimental groups extinguished more quickly. The interpretation of these data was that Ss in the experimental groups had a greater expectancy for reward than the control Ss when the light was on. Thus nonreinforcement was more frustrating for them and extinction occurred relatively more quickly.

In addition, there is evidence to suggest that expectancy for reward or success may be related to chronological age (CA) and mental age (MA). Ryan, Orton and Pimm (Journal of Experimental Psychology, 1967, in press) had 120 Ss at each of five developmental levels (Grade 2, Grade 4, Grade 6, college freshmen and old age) perform a lever-pulling task. Six reward groups (0, 10, 30, 50, 70 and 100%)

were formed at each age level. The results replicated the finding of faster response speeds for 50% as compared to 100% reward groups, from kindergarten to Grade 6 (Ryan and Moffitt, 1966; Ryan and Voorhoeve, 1966). However, as CA increased, reward schedules lower than 50% also resulted in more vigorous responding relative to 100% reward. Thus for Grade 2 and Grade 4 Ss, 30% reward resulted in significantly faster responding than 100% reward; at the Grade 4 and 6 levels, a similar finding was evident for the 10% reward schedule. These data were interpreted as showing that for young children a minimum number of rewards must be received in order to maintain reward expectancy. Reward expectancy, defined in terms of the number of rewards received, was considered as probably serving a less important role as Ss reach middle childhood. It was suggested that, perhaps, older Ss set up their own expectancies based on past experience rather than on the specific situation. For both old age and freshmen Ss, speeds increased significantly over training but there were no significant differences among the reward schedule groups. It was concluded that the same process used to explain differences between kindergarten and middle elementary school children were not applicable to adult data.

Cromwell (1963) and Stevenson and Zigler (1958) have proposed that retardates have a lower expectancy for success than normal children. Moffitt and Ryan's (1966) spaced trial study of the FE included 20 retarded children in each of the 50% and 100% reward groups. Contrary to the results for the normals, no FE was found for retardates. Ryan and Watson (1967) suggest the conclusion that retardate's performance increases to a lesser extent than normals following nonreward should be qualified. First, this may be the case only in certain situations of failure or nonreward and, second, although the conclusion may be true of retardates as a group, some retardates do show marked increases in performance following frustration.

The present investigation sought, within the framework of frustrative nonreward theory (Amsel, 1958), to examine the relationship between reward expectancy (in terms of number of previous reinforcements) and children's response speeds. An additional interest was the effect of sudden shifts from continuous to partial reward schedules, and vice versa, upon response speeds.

METHOD

Subjects

The Ss were 44 male and 45 female Grade 1 children (mean CA = 78.5 months; range = 74.0 to 95.0 months) obtained from a public school in London, Ontario. None of the Ss had any known physical handicaps.

Apparatus

The apparatus (see Figure 1) consisted of a large, grey lever-box with a 15 x 20-inch front panel inclined at a 45 degree angle from the vertical. A lever protruded from a 15-inch excursion channel located in the centre of the front panel; movement of the lever was in a downward, forward direction. The excursion channel was surrounded by an 18 x 3-inch stimulus panel, constructed of transparent plastic. A white "ready-button" was located at the bottom right of the front panel. At the bottom of the lever-box, directly beneath the lever arm, a 1 x 2 x 4-inch box served as a receptacle for marbles ejected from the lever-box.

Measures of response time were provided by three .01-second Meylan clocks. The first was activated when E pushed the "start" button at the back of the lever-box, thus turning on the stimulus light. A microswitch terminated the first clock and activated the second when S removed his hand from the ready button. At the initial movement of the lever arm, a second microswitch terminated the second and started

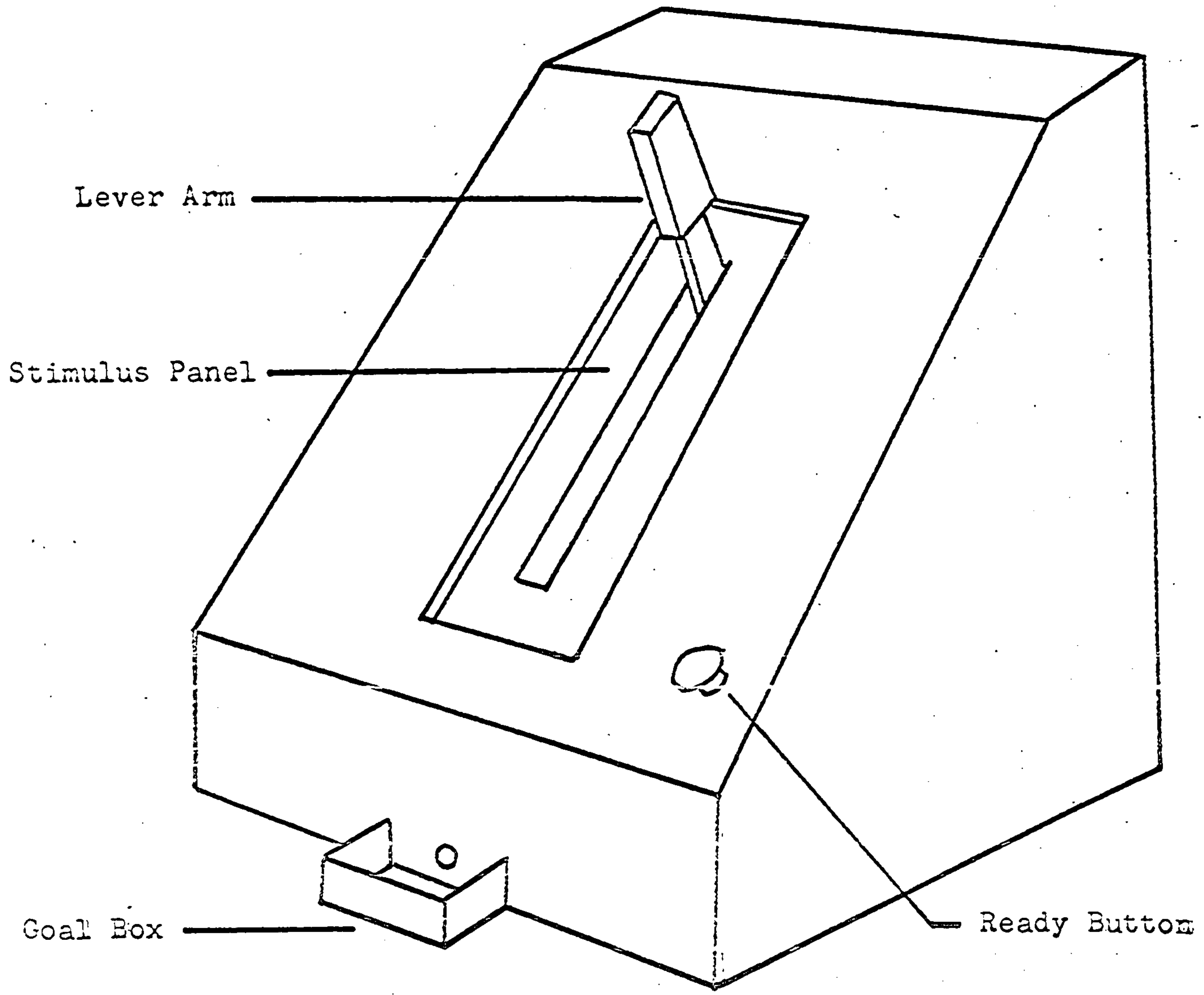

FIGURE 1

Lever-box used in the experiment

the third clock. Finally, the third clock terminated when the lever arm passed through a photobeam 1 inch from the bottom of the excursion channel. Thus, the response measures were reaction time (from onset of the stimulus light until S removed his hand from the ready button), starting time (the time taken by S to move his hand from the ready button to the lever) and movement time (the duration of the lever-pull itself).

An additional piece of apparatus (see Figure 2) consisted of a blue 5 x 5 x 6-inch box mounted on a metal stand. Fitted on to the front of this box was a plastic View-Master slide viewer of the type sold in most toy stores. A metal tube protruded from the top of the box. The box was designed so that, by dropping a marble into the metal tube, a microswitch could be tripped and a light would come on inside the box for a period of 4 seconds. The light served to illuminate slides placed in the View-Master.

The experiment was carried out in two different rooms in the school. The first 63 Ss were tested in one room and the last 26 in the other. For all Ss the experimental situation consisted of only two tables and one chair. The lever-box and Heylan clocks were on one table and the slide projector box was on the other—about 5 feet to the S's left as he faced the lever-box.

Procedure

Subjects were addressed as a group by their teachers in their classrooms and were told that they would be invited to come, one at a time, with E to "play a game." The Ss were subsequently brought

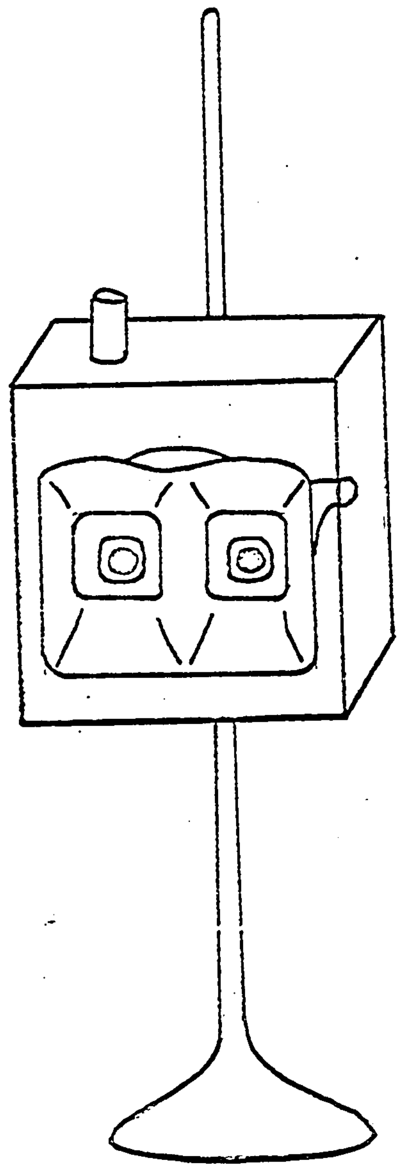

FIGURE 2

Slide-viewing apparatus used in the experiment individually in a random order to the laboratory. All Ss were assigned in a prearranged random fashion to one of four groups.

Upon entering the laboratory, each S was told to stand in front of the slide projector box and was given the instructions (see Appendix A). Subjects were instructed that they were going to play a game in which they could see pictures. They were shown that they could illuminate a slide by dropping a marble into the metal tube on top of the slide projector box. Each S was allowed to see two slides and was shown that, by pulling the lever on the side of the view-master, the next slide could be produced. A pile of slide cartridges depicting various entertainment characters (Batman, Lassie and Timmie, Top Cat, etc.) was shown to each S and they were told that, if they could win a marble every time they tried, they would see all the slides.

The Ss were then shown the lever-box and instructed to place their right hand on the ready button when E said "ready". They were to pull the lever down quickly when a red light came on behind the stimulus panel. The E noted the preferred hand of each S at the beginning and attempted to place equal numbers of left-handed Ss in each of the four experimental groups. It was emphasized to each S that it was necessary to win a marble every time in order to see a picture every time. Subjects were told that, if they did not win a marble, they would have to wait until their next turn.

After the instructions had been given, Ss were given two rewarded practice trials followed by 48 test trials. Throughout the session, E was seated behind the lever-box, facing S. On each trial, the interval between E's "ready" and onset of the stimulus light was about 2 seconds, while the intertrial interval was about 20 to 25 seconds. During the intertrial interval, S was allowed to use the marble which he might have won to see a slide, while E recorded reaction, starting and movement times to the nearest .01 second. Each slide cartridge contained seven slides and Ss were allowed to change cartridges whenever they so desired.

Design

Two types of reward schedules and four groups of Ss were employed. The reinforcement schedules were 100% and 50% random reinforcement. One group of Ss (100 - 50) received 100% reinforcement during the first 24 trials (preshift phase) and then received 50% random reward during the last 24 trials (postshift phase). Another group (100 - 100) received 100% reinforcement on all 48 trials. The third group of Ss (50 - 100) received 50% reward during the preshift phase and 100% reward during the postshift phase. Finally, a fourth group of Ss (50 - 50) received 50% random reinforcement on all 48 trials. There was no interruption between the preshift and postshift phases. The reward schedules for all four groups are presented in Appendix B, Table 1.

The assignment of Ss to the groups was random except for the contingencies that there was equal representation of the sexes and that there were approximately equal numbers of left-handed Ss in the groups.

The overall design can be viewed as a three-factor experiment with two between-group variables—sex (male and female) and groups (100 - 100, 100 - 50, 50 - 50 and 50 - 100)—and one repeated measure (trials).

Predictions

The study was designed to manipulate the variable reward expectancy, defined as a function of the number of reinforced trials experienced by Ss. Groups 100 - 100 and 50 - 50 were included as control groups so that their performance could be compared to those of Groups 50 - 100 and 100 - 50 on the postshift phase.

In accordance with previous findings (Bruning, 1964; Ryan and Moffitt, 1966; Pederson, 1967; and Ryan, 1966), the first prediction (1) was that the asymptotic movement speeds of the partially reinforced Ss, in the preshift phase (i.e., by trial 24), would be faster than those of continuously reinforced Ss. Previous data (e.g., Pederson, 1967) indicate that the movement speeds of children reach an asymptotic level after about 20 trials and, thus, the second prediction (2) was that the movement speeds of Groups 100 - 100 and 50 - 50 would remain fairly stable during the postshift phase. The third prediction (3) was that during the postshift phase, the movement speeds of Group 100 - 50 would increase abruptly as compared to the speeds of Group 100 - 100 and would continue to increase until trial 48. This was expected because the Ss of the 100 - 50 Group would experience frustration on nonrewarded postshift trials and this frustration would eventually become the learned, anticipated frustration mechanism $r_f - s_f$. In addition, it was hypothesized that the reward expectancy of Group 100 - 50 Ss would be greater than that of 50 - 50 Ss due to the continuous reward they received on preshift trials. Therefore, nonreward in the postshift phase would be more frustrating and it was predicted

(4) that the movement speeds of the 100 - 50 Ss would be faster by trial 48 than those of 50 - 50 Ss.

The fifth hypothesis (5) was that the postshift movement speeds of 50 - 100 Ss would gradually decrease as anticipatory frustration extinquished under continuous reward. No predictions were made concerning reaction or starting speeds.

RESULTS

The mean ages of the Ss of the four experimental groups (50 - 50, 50 - 100, 100 - 100, 100 - 50) were 79, 80, 78, and 81 months, respectively.

Of the 89 Ss tested, the data for one S was omitted from the data analyses because she indicated a dislike for the "game". Due to an error on the part of E, unequal numbers of Ss of each sex were assigned to the groups. Therefore, the data for eight Ss were randomly omitted from the analyses so that ten males and ten females were left in each of the four groups.

All the measures for reaction, starting and movement times were converted to speeds (1/t in secs.) and were blocked with six trials per block. The average speed scores of the trial blocks were the basic data for the analyses. The three sets of speed scores were analyzed separately and because there were more significant tests found for the movement speed analyses, they will be presented first.

Movement Speeds

Figure 3 presents the mean movement speeds of Ss under 50% and 100% reinforcement conditions during the preshift phase. As can be seen, the speeds of the 50% reward group increased at a greater rate over the four trial blocks than those of the continuous reward groups. A three-factor analysis of variance was carried out on these movement speeds. The two between-Ss factors were reinforcement schedules

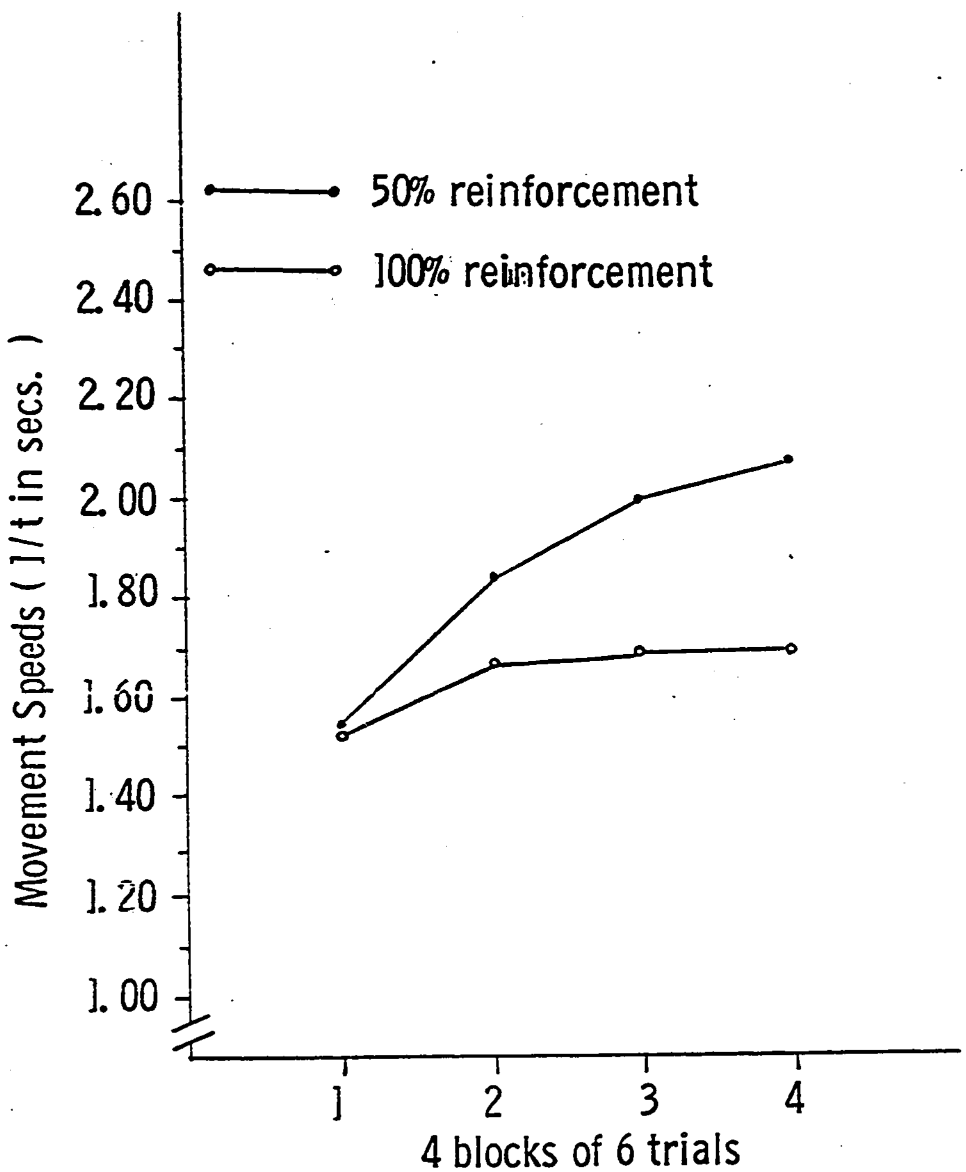

FIGURE 3

Preshift movement speeds for partially and continuously reinforced groups

(50% vs 100%) and sex (male vs female). The within-Ss comparisons were across trial blocks. The analysis (see Appendix B, Table 1) showed a significant increase in performance over trials ($F = 36.51$, $df = 3, 228$, $p < .001$) and a trials-by-reward schedules interaction ($F = 9.55$, $df = 3, 228$, $p < .001$). The F-ratio for reward schedules was nonsignificant ($F = 2.62$, $df = 1, 76$). It is clear from Figure 3 that the trials-by-reward schedules interaction is due to the fact that the faster performance of the partial reinforcement group did not occur until the latter trials of the preshift phase.

A comparison of the mean movement speeds of males and females over the preshift trials (see Appendix B, Table 2) revealed that the difference between the speeds of the 50% and 100% reward groups was much more distinct in the males. Therefore, a separate analysis of variance was done on the preshift movement speeds of male Ss only (see Appendix B, Table 3). Again, the analysis revealed a significant trials effect ($F = 21.10$, $df = 3, 114$, $p < .001$) and trials-by-reward schedules interaction ($F = 6.23$, $df = 3, 114$, $p < .001$). There was also a PRAE or significant reinforcement groups effect ($F = 4.24$, $df = 1, 38$, $p < .05$). The means presented in Appendix B, Table 2 also indicated that the PRAE would not be significant for the data of female Ss and, therefore, a similar analysis of variance was not carried out on this data.

Figure 4 presents the mean movement speeds of the four experimental groups as a function of trial blocks. An analysis of variance on the data for the preshift trials is presented in Appendix B, Table 4. There was a significant trials effect ($F = 36.40$, $df = 3, 216$, $p < .001$)

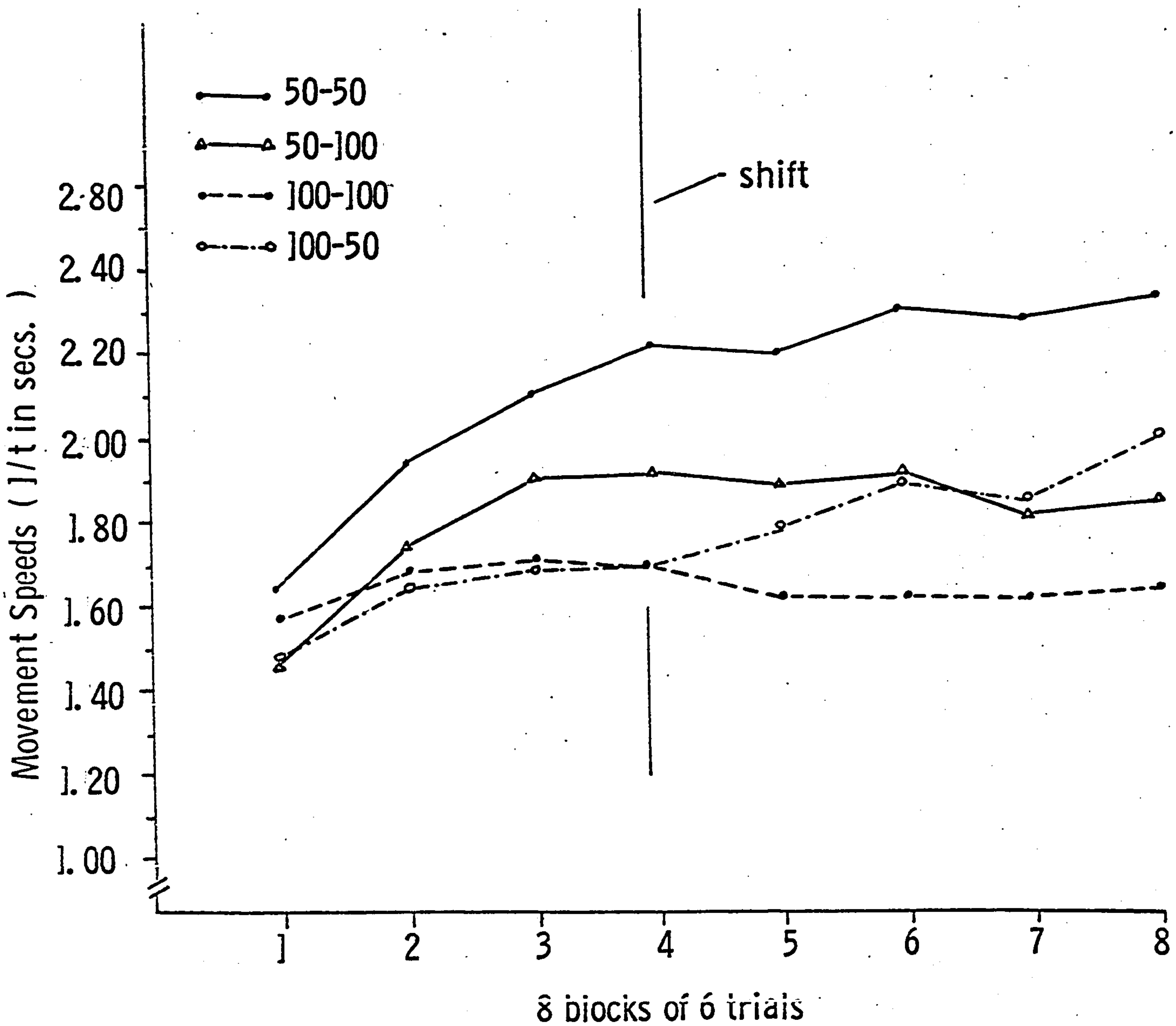

FIGURE 4

Movement speeds of the four experimental groups and groups-by-trials interaction ($\underline{F}$ = 3.43, $\underline{df}$ = 9, 216, $\underline{p}$ < .005). It is evident in Figure 4 that the significant interaction was due to a greater increase in response speed over trials of the partially reinforced groups (i.e., Groups 50 - 50 and 50 - 100) relative to the continuously reinforced groups (i.e., Groups 100 - 100 and 100 - 50).

A similar analysis of variance of the postshift movement speeds of the four experimental groups is presented in Appendix B, Table 5. There was a significant main effect for groups ($\underline{F}$ = 3.38, $\underline{df}$ = 3, 72, $\underline{p}$ < .025) and trials ($\underline{F}$ = 3.70, $\underline{df}$ = 3, 216, $\underline{p}$ < .025), as well as a significant groups-by-sex interaction ($\underline{F}$ = 3.47, $\underline{df}$ = 3, 72, $\underline{p}$ < .025). Figure 4 illustrates that the trials effect was due to an increase in speeds over trials in the two groups receiving partial reinforcement during the postshift phase (i.e., Groups 50 - 50 and 100 - 50). The main effect for groups appears to have been due to initial fast response speeds for Group 50 - 50, which were maintained during the postshift trials. This, coupled with decreasing speeds for Group 50 - 100, increasing speeds for Group 100 - 50, and steady slower speeds for Group 100 - 100, led to a separation of the movement speed curves of the four groups.

Because of the significant groups-by-sex interaction, the movement speeds of the four experimental groups over the eight trial blocks were analyzed separately for the two sexes and the mean movement speeds are plotted in Figures 5 and 6. It is clear that the main effect for groups is evident for the male groups but not the female groups during the preshift and postshift phases. The analyses of variance carried out separately on the postshift movement speed data for the two

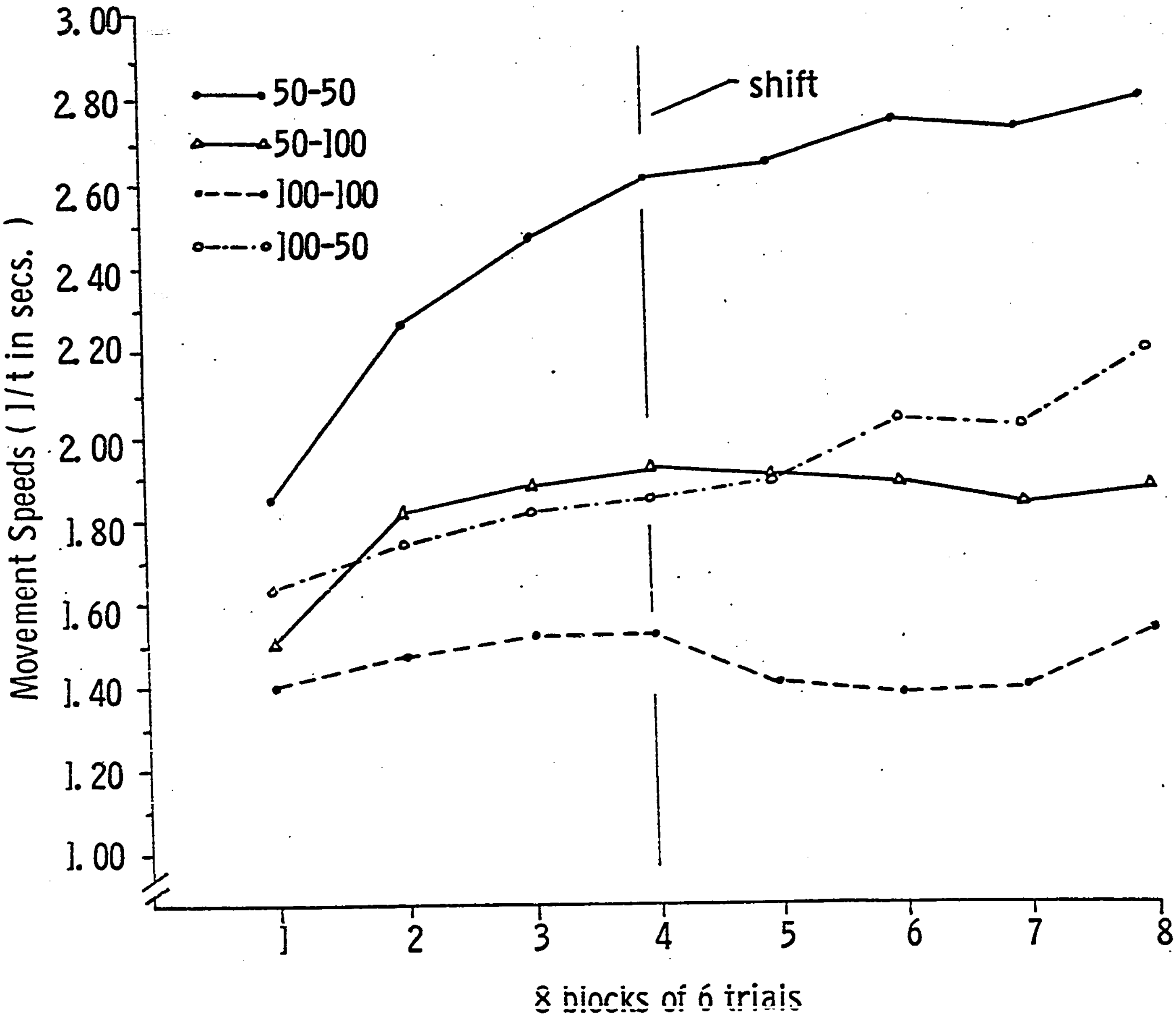

FIGURE 5

Movement speeds of male subjects

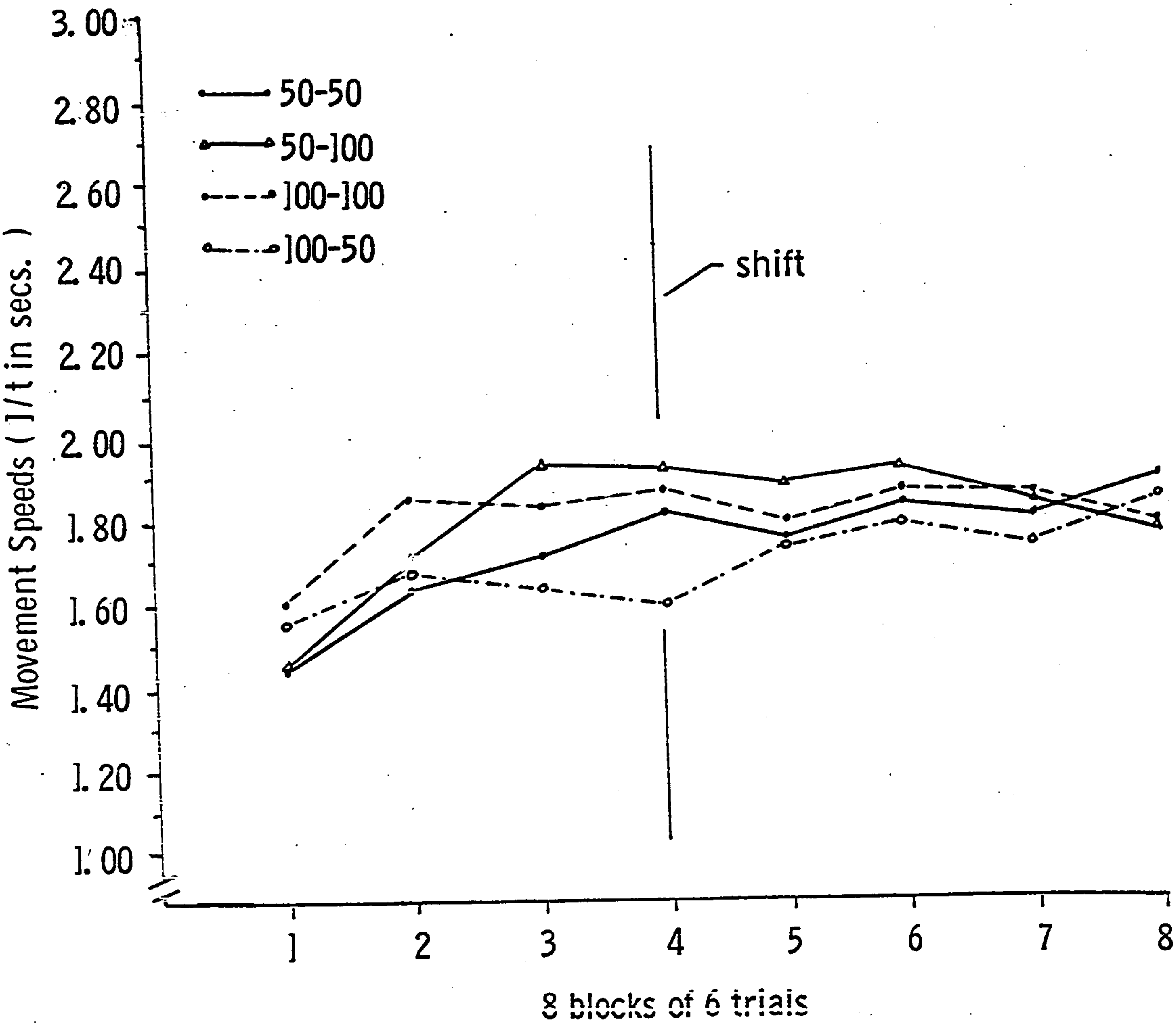

FIGURE 6

Movement speeds of female subjects

sexes concerned three factors. One between-Ss factor was the preshift reinforcement condition (50% or 100%) and the other was the postshift reinforcement condition (50% or 100%). The within-Ss comparisons were across the four postshift trials. The purpose of this analysis was to determine the relative effects of the preshift and postshift reward conditions on postshift performance.

The summary of the analysis on the male groups is presented in Appendix B, Table 6. The F-ratio for the preshift reinforcement condition was significant ($F = 6.26$, $df = 1, 36$, $p < .025$) and Figure 5 indicates that the groups which received preshift 50% reward had greater postshift response speeds. Also significant was the F-ratio for postshift reinforcement condition ($F = 9.29$, $df = 1, 36$, $p < .005$) indicating that those groups receiving 50% reward during the postshift phase responded faster than the continuous reward groups during the postshift phase. Finally, the analysis again showed a significant trials effect ($F = 3.06$, $df = 3, 108$, $p < .05$) indicating an increase in speeds over the postshift trials. As can be seen in Figure 5, this increase in movement speed occurred in Groups 50 - 50 and 100 - 50. The same analysis of variance was calculated for the female groups and is shown in Appendix B, Table 7. There were no significant main effects or interactions.

Since the differential effects of partial or continuous reinforcement, as well as the effects of shifts from one reinforcement schedule to the other, did not appear to be distinct for the groups of female Ss, further analyses were carried out only on the data for male Ss. An analysis of variance (Appendix B, Table 8) was conducted on the data for the male groups 50 - 50 and 50 - 100. This analysis was on the postshift movement speeds only and was carried out with the purpose of finding whether or not Group 50 - 100 speeds decreased significantly over trials as compared to Group 50 - 50 speeds. There was no significant groups-by-trials interaction (F = 0.82, df = 3, 54). A significant main effect for groups (F = 4.84, df = 1, 18, $p < .05$) indicated that the 50 - 50 reward group responded faster than the 50 - 100 group.

A similar analysis was carried out on the male groups 100 - 100 and 100 - 50 (Appendix B, Table 9). The analysis showed a main effect for groups (F = 4.58, df = 1, 18, $p < .05$) indicating that Group 100 - 50 speeds were faster than those of Group 100 - 100. There was also a significant F-ratio for the trials effect (F = 4.20, df = 3, 54, $p < .01$). The significant trials effect was evidently due to (see Figure 5) the increasing response speeds of Group 100 - 50 over the four postshift trial blocks.

Reaction and Starting Speeds

The first analyses of reaction and starting speeds compared the preshift speeds of groups receiving either partial or continuous reinforcement. Appendix B, Table 1 presents the analysis for the reaction speeds. The only significant F-ratio was that for the trials effect (F = 17.91, df = 3, 228, $p < .001$) and the mean reaction speeds presented in Appendix D, Table 1 indicate that reaction speeds increased over trials.

Appendix B, Table 2 presents the summary of the analysis of the preshift starting speeds of the 50% and 100% reinforcement groups.

Again, there was a significant trials effect (F = 23.92, df = 3, 228, $p < .001$), but no significant groups effect or PRAE. Figure 7 shows the mean starting speeds of the partial and continuous reward groups across the four preshift trial blocks. Starting speeds of the partial reward groups are faster at each trial block but this difference is less than that noted in Figure 3 for movement speeds.

Analyses of variance were also done on the reaction and starting speeds of the four experimental groups, separately for the preshift and postshift phases. The summary of the analysis for the preshift reaction speeds is presented in Appendix C, Table 3. Only a trials effect (i.e., increase in reaction speeds over trials) was evident (F = 17.65, df = 3, 216, $p < .001$). Table 4 of Appendix C presents the summary of the same analysis of postshift reaction speeds. There was a significant groups-by-trials interaction (F = 1.95, df = 9, 216, $p < .05$) and Appendix D, Table 1 indicates that this interaction was due to increases in reaction speeds over trials in Groups 50 - 50 and 100 - 50. The speeds for Group 100 - 100 were fairly constant over trials while those of Group 50 - 100 decreased slightly. Tables 5 and 6 of Appendix C show the analyses for preshift and postshift starting speeds. During the preshift phase only a trials effect was evident (F = 23.71, df = 3, 216, $p < .001$) and there were no significant main effects or interactions for the postshift phase (see Figure 8).

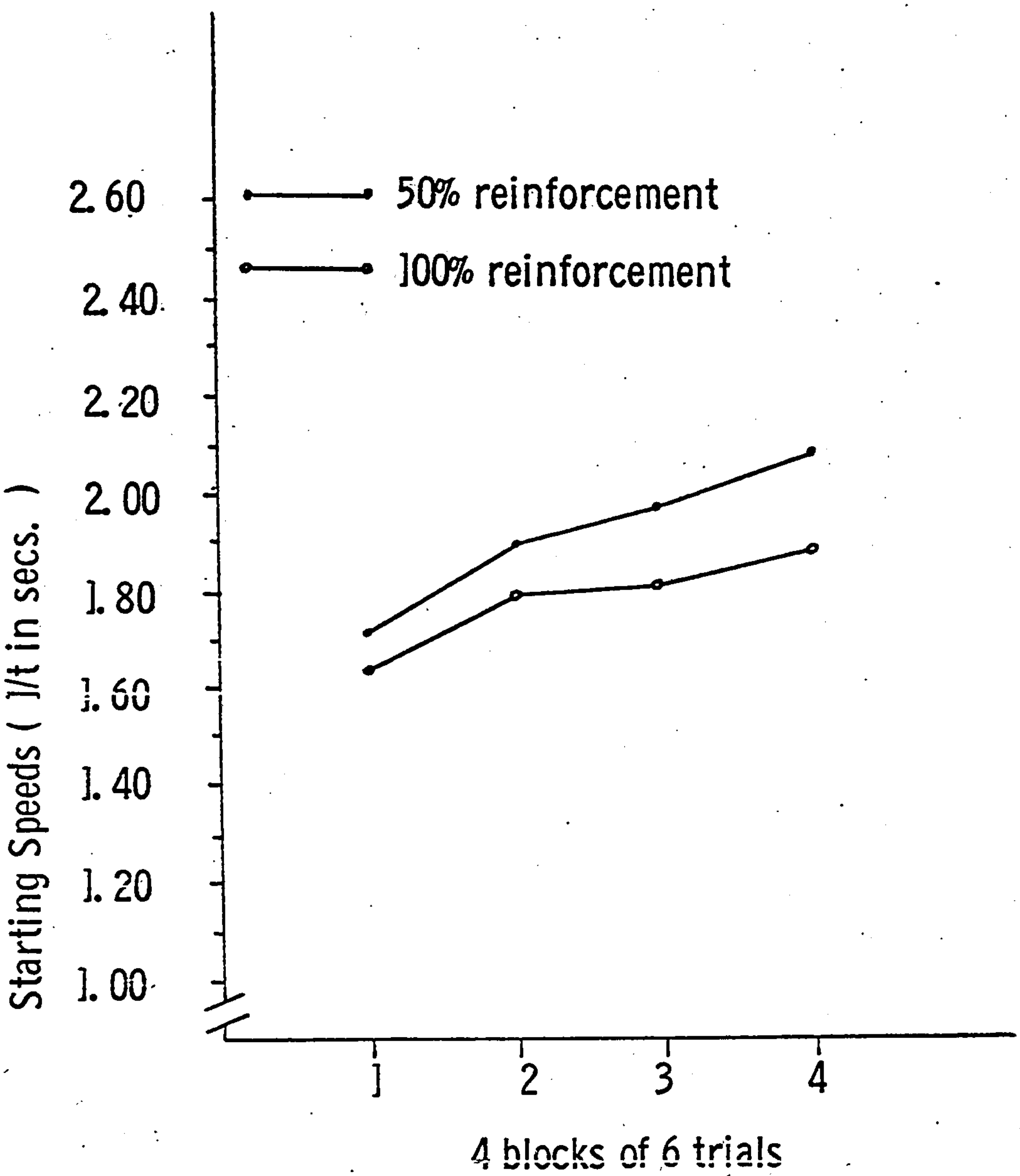

FIGURE 7

Preshift starting speeds for partially and continously reinforced groups

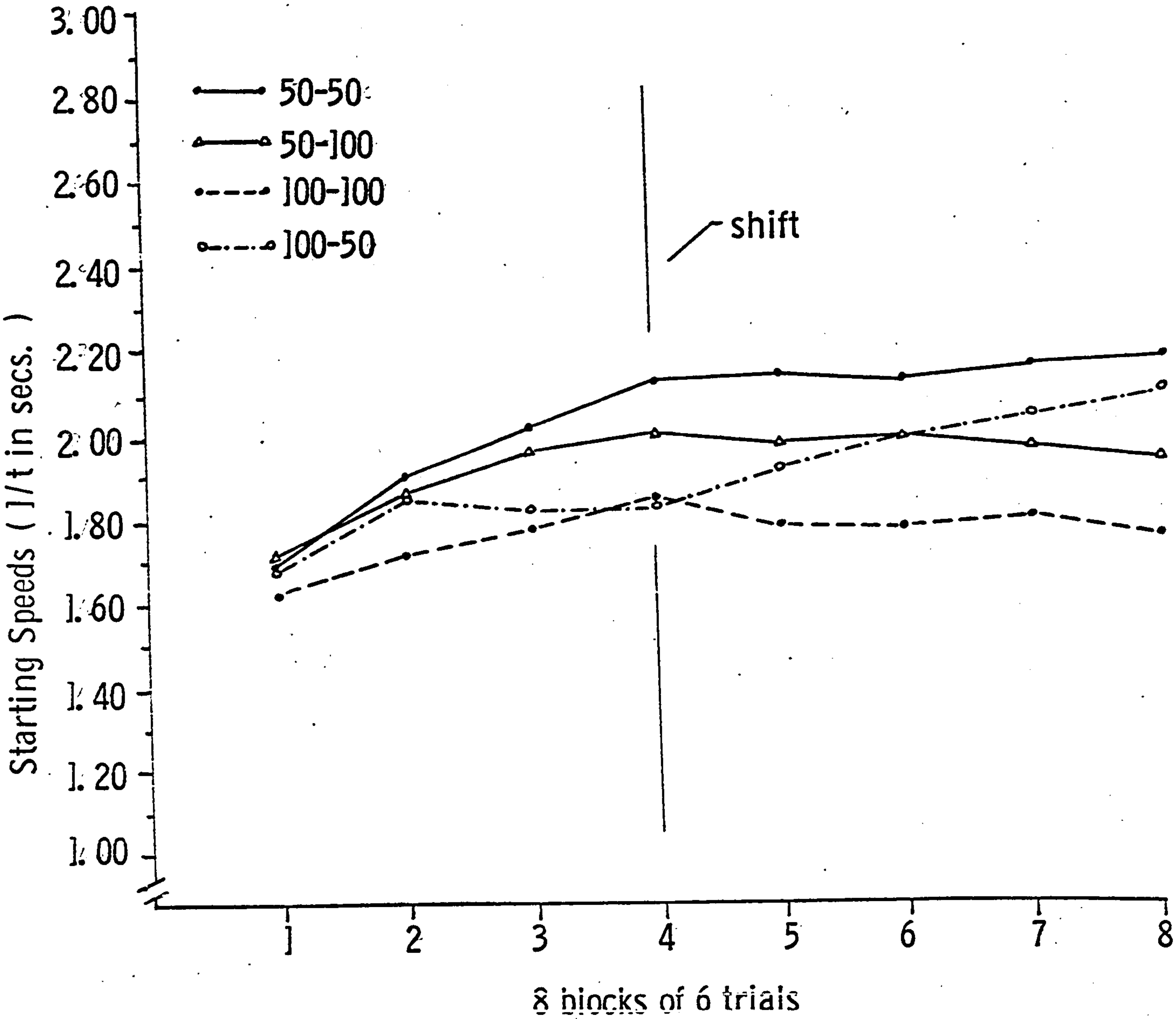

FIGURE 8

Starting speeds of the four experimental groups

DISCUSSION

Summary of Results

The results of the present study may be summarized as follows:

(a) There was a significant experimental group-by-trials interaction for the postshift reaction speed data. This was the result of increasing speeds for Groups 50 - 50 and 100 - 50 and decreasing speeds for Group 50 - 100. There were no other significant differential effects of reward schedules or reward schedule shifts upon preshift and postshift reaction and starting speeds.

(b) Analysis of the preshift movement speeds showed that the speeds of the partially rewarded groups did increase at a significantly greater rate than those of the continuously rewarded groups. A separate analysis of the preshift movement speeds of males only revealed a significant main effect for reward schedule as well as a reward schedule-by-trials interaction.

(c) There was a significant main effect for groups in the postshift movement speeds. This was due to the fact that Ss of Group 50 - 50 responded fastest, Groups 100 - 50 and 50 - 100 responded slower, and Group 100 - 100 responded slowest. Also, the post-shift movement speeds of Groups 50 - 50 and 100 - 50 increased over trials as compared to those of Groups 100 - 100 and 50 - 100.

(d) Further analyses showed that although Group 100 - 50 postshift movement speeds increased relative to Group 100 - 100, and Group 50 - 100 speeds decreased relative to Group 50 - 50, these differences were non-significant.

Interpretation and Procedural Problems

There were initial differences between the movement speeds of the four experimental groups during the preshift phase which made interpretation of the effects of percentage of reward shift difficult. For example, the movement speeds of Group 50 - 50 were much faster than those of Group 50 - 100 during the preshift phase. This difference was probably due to the chance assignment of faster responding Ss to Group 50 - 50.

As can be seen in Figure 4, the postshift movement speeds of Group 100 - 50 did increase as compared to Group 100 - 100 speeds which decreased slightly. Also, as predicted, Group 50 - 100 speeds dropped slightly while those of Group 50 - 50 continued to rise. These trends were more evident for male Ss (see Figure 5) than female Ss (see Figure 6) but were still nonsignificant for either sex.

One of the predictions made was that the postshift movement speeds of Group 100 - 50 would rise to a higher level than those of Group 50 - 50 by trial 48 because of a greater reward expectancy built up under the continuous reward condition in the preshift phase. It is not immediately evident in Figure 4 whether this was, in fact, the case because the movement speeds of Group 50 - 50 were faster than those of the other groups from the first trial block on. However, from trial block four to trial block eight, Group 100 - 50 did show an increase in response speed of .426 units, while Group 50 - 50 increased only .125 units. This difference was not significant.

It was, of course, necessary to show that the Ss of the partial reinforcement groups were frustrated by nonreward during the 24 preshift trials and that this frustration had become anticipatory and conditioned to the instrumental lever-pulling response. There was no strong evidence of the PRAE in the movement speed data. The performance of the partial reward groups was superior to that of the continuous reward groups only by the end of the preshift phase. Several factors were noted which could have resulted in the large variability of the scores within-groups and thus the lack of significance of the between-groups tests. One of these factors was sex. There were no clear-cut effects among the female Ss. There seems to be little explanation for this other than, in general, a reaction to frustration must be compatible with the male sex role while the female sex role demands a more passive reaction. Whiteley and Ryan (1967) have also found sex differences in a double-lever study of the FE. Their results showed the starting speeds of males to be faster than those of females. On the other hand, Ryan and Voorhoeve (1966) conducted a study which employed a single-lever apparatus and several different reward schedules. They found that sex did not enter into any significant relationships with any variables, either in the acquisition or the extinction of the lever-pulling response.

Another factor which could have contributed to the variability of the scores was the motivation of the Ss. On several occasions E observed overt exclamations of surprise or delight on the part of Ss when they discovered that the next slide cartridge contained pictures of their favourite entertainment character (e.g., "Oh boy, Top Cat!"). These exclamations were often accompanied by sudden increases in movement and starting speeds. It was also noted by E that response speeds were generally faster for the lever-pulls following the first two or three slides on any cartridge. Also, some Ss showed overt signs of disappointment on nonrewarded trials while others seemed relatively indifferent. It is possible that the pictures were not an adequate reinforcer for many of the Ss. Nevertheless, Pederson (1966) used slides as rewards and clearly demonstrated the PRAE. However, his Ss were allowed to choose the slide cartridges that they wished to see before the experiment and this procedure may have resulted in more uniform motivation among the Ss.

A further point should be made with regard to the motivation of the Ss. It is possible that some of the Ss were only doing as they had been instructed to do rather than taking a more active interest in the game. It might have been better if the Ss had been asked to volunteer to participate. Ryan and Voorhoeve (1966) have found some results relevant to this view. They reported that groups of Ss given

40 acquisition trials on various reinforcement schedules and then given 30 extinction trials, continued to respond for the full 30 extinction trials. It was concluded that complete extinction may not occur so long as Ss have been instructed by an adult to pull the lever every time the stimulus light is presented. Several of their Ss verbalized early in extinction that no marbles were left in the apparatus but, nevertheless, they continued to respond. Ryan and Voorhoeve suggested that a better procedure might have been to instruct Ss that they were free to leave at any time.

The usual finding of faster response speeds which result from partial reinforcement are considered to be due to two sources of frustration. Anticipatory frustration becomes conditioned to stimuli early in the response sequence or, more generally, to the stimuli of the experimental situation. Also, if the intertrial interval is short enough, primary frustration resulting from nonreinforcement perseverates from one trial to the next and this increase in drive level aides in producing faster response speeds. Watson and Ryan (1966) employed inter-response intervals of 5, 10 and 20 secs. in a double-lever study (R_1 and R_2) of the FE. Analyses of the R_2 movement speeds showed that at the 5 sec. interval, speed following nonreward was faster than speed following reward. For other intervals, R_2 movement speeds were not related to reward conditions at R_1. It was concluded that the effects of primary frustration are rather short-lived. However, Ryan (1965) used an intertrial interval of 45 secs. and was able to demonstrate a FE, but only in the starting speeds. It was suggested that the absence of the effect on R_2 movement speeds might have been due to the perseveration of frustration from one trial to the next. The present study employed a relatively long intertrial interval of about 25 sec. On trials on which Ss changed slide cartridges this interval was even longer. Although there seems to be some disparity in the literature as to the duration of primary frustration, it is possible that in the present study, primary frustration dissipated between responses and did not contribute to the demonstration of a PRAE. Most of the previous studies which have demonstrated the PRAE have used a relatively short intertrial interval of 8 to 10 secs. (e.g., Ryan and Cantor, 1962; Ryan, 1966; Ryan and Voorhoeve, 1966; Ryan and Moffitt, 1966.)

Contrast Effects

The design of the present investigation is similar to those which have studied contrast effects. The term "contrast effect" (CE) was borrowed from students of sensory processes and perception and refers to a sudden change in response to a stimulus as a function of the previous stimulus presented. Studies of contrast effects have involved shifts in the magnitude or quality of rewards, delays of reward, and schedules of reward.

The negative CE is a sudden drop in performance (e.g., running speed of rats) upon a shift from a large reward magnitude to a small reward magnitude, to a level below that of a control group which has continued to run to a small reward magnitude. The positive CE is a sudden increase in performance upon a shift from small to large reward magnitude to a level above that of a control group running for a large reward.

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A fundamental distinction has been made between experimental designs concerned with the "successive" CE and those concerned with the "simultaneous" CE (Black, 1968). In studies investigating the successive CE, Ss are initially given consistent experience (training) with one level of reward magnitude (for example) and are subsequently shifted to a different magnitude in the same or a similar task. The simultaneous CE involves giving Ss two or more reward magnitudes in some intermixed order throughout training. For example, S may be given differential conditioning such that some trials are run in one alley (A1) and some in a second alley (A2), with the reward in A1 being larger than that in A2.

Most studies of the CE have involved shifts in reward magnitude or delay of reward and have generally demonstrated the negative CE but not the positive CE (see Black, 1968). Weiss (1965) conducted an experiment to demonstrate the simultaneous CE by contrasting reinforcement schedules. Rats were given differential conditioning in a pair of straight runways. A comparison of the performances of Groups 100% - 0% and 50% - 0% in the 0% reinforcement runway showed Group 100% - 0% was not inferior to Group 50% - 0% as would be the case had a negative CE occurred.

Badia (1965) has conducted an experiment which manipulated schedules of reinforcement successively at different drive levels. Groups of rats ran in a straight-alley runway at one of three drive levels and one of two reinforcement schedules (50% or 100%). Following 88 acquisition trials, the percentage of reinforcement was reversed for all Ss and an additional 32 trials were given. Partially reinforced groups performed at an inferior level early in training but following extended trials their performance was, if not greater, at least equal to continuously reinforced Ss. The effects of reinforcement schedule shifts were opposite to the negative CE. For high- and medium-drive groups, the shift from continuous to partial reinforcement resulted in increases in starting and running speeds. However, for the low-drive group this shift led to no significant increases in response speeds. It was suggested that under conditions of low drive and discontinuous reward, r_f may develop minimally or not at all. This suggestion is particularly relevant to some of the arguments mentioned above concerning the level of motivation of the Ss employed in the present experiment. Badia (1965) also reported that shifting from a partial to a continuous schedule had little effect upon response measures for high- and medium-drive groups but for low-drive Ss caused an increase in running speed. He concluded that, while 32 trials may be necessary to acquire the r_f response, considerably more trials may be necessary to extinguish it.

In the case where percentage of reinforcement is shifted successively, the prediction of a contrast effect is opposite to the predictions made in the present study on the basis of Amsel's (1958, 1962) frustration model. In view of the results of Weiss (1965) and Badia (1965), as well as those of the present study, it appears as if the effects of shifts in reinforcement schedules are quite different from those associated with delay of reward and reward magnitude.

<u>Incentive Motivation and Frustration Theory</u>

Frustrative-nonreward has encountered some difficulties in accounting for the results of research dealing with variables other than reward expectancy. For example, in Hull-Spence theory it is assumed that such variables as magnitude of reward and incentive value determine the strength of K, an intervening variable which represents, quantitatively, the motivational property of the conditioned $r_g - s_g$ mechanism. Nonreward is more frustrating if the $r_g - s_g$ mechanism is strong than if it is weak. Animal studies have demonstrated that magnitude of reward is directly related to asymptotic level of performance (e.g., Crespi, 1942). However, reward magnitude in child studies has not proven to be an effective variable.

Bruning (1964) demonstrated the PRAE on a single-lever apparatus using kindergarten children as <u>S</u>s. Half of the <u>S</u>s were rewarded with one piece of candy and half with five pieces of candy. Larger magnitude of reward was found to have a slight, but nonsignificant, <u>decremental</u> effect upon performance.

In a double-lever study by Ryan (1965), it was assumed that nonreinforcement would be more frustrating if the relevant incentive was one of high rather than low preference. Kindergarten children received marble rewards which could later be traded for one of six toys which had been previously ranked by the <u>S</u>s on a preference scale. High incentive <u>S</u>s received their first ranked toy while low incentive <u>S</u>s received their least preferred toy. The FE was found, in that response speeds following nonreward were faster than following reward. However, no significant differences were obtained with respect to the incentive variable.

In a subsequent experiment (Ryan and Moffitt, 1966), Ss in the low incentive condition were informed that they could trade their marbles for a piece of string after the game was over. For the high incentive group, marbles were traded for a toy. An unexpected finding was that the low incentive group exhibited increasingly faster movement speeds when compared to the high incentive Ss. Exactly the opposite outcome had been expected. It was assumed that the low incentive Ss became aroused when they had been informed that they could only win the string and, therefore, had been tested at a higher drive level. This evidence, in the light of the more consistent findings of studies which have used rats as Ss and varied reward magnitude (e.g., Czeh, 1955; DiLollo and Beez, 1966) or reward incentive (e.g., Collier and Marx, 1959), raises some doubts about frustrative-nonreward theory as currently applied to child Ss.

The theory has also encountered difficulties in accounting for animal data and Hill (1968) has attempted to clarify some of the ambiguities. One of these has been the finding that the PRAE is confined to the starting and running speeds of rats in straight runways (e.g., Goodrich, 1959). Close to the goal, continuously reinforced groups run faster. These results have been interpreted (Wagner, 1961; Amsel, Rashotte and MacKinnon, 1966) on the grounds that anticipatory frustration either is so strong or comes on so sudden near the goal that the resultant aversiveness is never fully overcome by the tendency to approach the goal. However, this interpretation meets with difficulty in that Wagner (1961) has found that the superiority of a partially reinforced group <u>in extinction</u> occurs in the early portions of the runway, as well as near the goal. It appears as if frustrative-nonreward theory needs to be seriously considered with regard to its adequacy in handling animal and human data and, at the very least, modifications need to be made.

<u>Future Research</u>

Several procedural modifications have been suggested for the present study which might have enabled the demonstration of a more distinct PRAE. However, although faster movement speeds on the part of partially rewarded groups were not evident early in training, this difference was apparent by the end of the preshift phase. In view of this, the effects of the shift from continuous to partial reinforcement on the performance of Group 100 - 50 were less than would be expected from the predictions made on the basis of Amsel's frustration model. It seems likely that the number of previous reinforcements children experience in an experimental situation has very little effect upon their reward expectancy and it is possible that reward expectancy is dependent upon past extra-experimental experience rather than situational variables. If this is the case, future research might better attend to individual differences. The same point has been made by Ryan and Watson (1968) who have reviewed studies which have shown relationships between personality variables and intellectual level and reaction to nonreward.

Perhaps the time has come to investigate conditioned and primary frustration in children in the context of more everyday types of situations. The effects of frustration may be quite different when a series of responses requiring skill is involved. Some studies reviewed by Ryan and Watson (1968) have indicated that under certain conditions nonreinforcement, when Ss are working toward a goal, constitutes a "failure" experience which has different effects upon performance than a frustrating experience (e.g., Ford, 1963). Amsel's (1958, 1962) frustration model has stimulated useful and significant research on children's reaction to nonreward but it remains to be seen if the theory will remain useful in predicting behaviour in more complex situations.

SUMMARY

Forty male and 40 female Grade 1 children were administered 24 preshift and 24 postshift trials on a single-lever apparatus. Equal numbers of male and female Ss were randomly assigned to one of four groups. Two groups (50 - 50 and 100 - 100) received either continuous or random 50% reinforcement on all 48 trials. The other two groups (100 - 50 and 50 - 100) were shifted, after the 24 preshift trials, from partial to continuous reinforcement or vice versa. The response measures were the reaction, starting and movement speeds of the lever-pulls. The rewards were marbles which could be used to see coloured slides during intertrial intervals.

It was predicted that anticipatory frustration would develop as a result of nonreward and that this frustration would become conditioned to the instrumental lever-pulling response causing the partially rewarded groups to exhibit faster movement speeds over the preshift trials (Amsel, 1958, 1962). It was also hypothesized that the reward expectancy (defined as a function of the number of previously reinforced responses experienced) of Group 100 - 50 would be greater than that of Group 50 - 50 so that, during the postshift trials, the movement speeds of Group 100 - 50 would increase to a level above that of Group 50 - 50. A further prediction was that the movement speeds of Group 50 - 100 would decrease, relative to those of Group 50 - 50, because of the gradual extinction of the frustration mechanism $r_f - s_f$. No specific

predictions were made concerning reaction and starting speeds. The findings of the study are as follows:

(a) During the postshift phase, the reaction speeds of partially reinforced groups (i.e., 50 - 50 and 100 - 50) increased at a greater rate than those of the continuously reinforced groups (i.e., 100 - 100 and 50 - 100). There were no other significant differential effects of reward schedules or reward schedule shifts upon preshift and postshift reaction and starting speeds.

(b) The preshift movement speeds of partially rewarded groups increased at a significantly greater rate than those of the continuously rewarded groups. This difference was also found in the data for male Ss, as well as a significant main effect for reinforcement schedule with the partial reward groups responding faster.

(c) As predicted, during the postshift phase the movement speeds of Group 100 - 50 did increase rapidly as compared to Group 50 - 50. Those of Group 50 - 100 did decrease relative to those of Group 50 - 50. However, none of these effects were statistically significant. All the trends observed were more pronounced for male Ss and were also observed in the starting speed data.

Several factors were suggested as being likely causes for the large variability of response speeds and the subsequent nonsignificance of the effects of the reward schedule shifts. One of these was that the Ss might have been at a low level of motivation and that this motivation fluctuated during the experiment as a function of the different slides viewed as reinforcements. It was also proposed that the relatively long intertrial interval (about 25 secs.) allowed primary frustration due to nonreward to dissipate. Finally it was suggested that the Ss might have participated more actively if they had been asked to volunteer to take part in the experiment.

Some comments were made as to the adequacy of frustrative nonreward theory in accounting for behaviour which is rewarded discontinuously. The theory has met with difficulty in explaining data from research done with animals as well as that which has manipulated magnitude of reward with children. It was suggested that the results of the present study were not comforting to Amsel's frustration model and that reward expectancy in children might be more of an individual difference rather than a function of experimental variables. It was also proposed that the theory be tested in experimental situations involving more complex behaviour.

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TABLE OF APPENDICES

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APPENDIX A

Instructions to Subjects and Reinforcement Schedules

INSTRUCTIONS TO SUBJECTS

Which is your best hand _________; the one you use to throw a ball? (E recorded S's handedness.)

This is a game in which you see pictures and you see the pictures by looking in here (E pointed to View-Master slide projector). Look in here. What do you see? If you want to see the next picture pull this handle down. (S was shown how to change to the next slide and was shown the next slide.)

You see, if you want to make a picture come on, you have to put a marble in here (E pointed to the tube in the slide projector box). When you have seen all these pictures then you can see some of these (E pointed to a nearby stack of slide cartridges). See? They are all different.

Now, I will show how you can win some marbles so that you can make the picture machine work. This is a marble machine (E pointed to the lever-box and instructed S to stand in front of it). You will get lots of turns to see if you win a marble from the machine. If you win a marble you can use it to see another picture. If you do not win a marble you will have to wait until your next turn. Now, for each turn, I will say "ready". When I say "ready" put this hand on the ready button and hold it in, like this. Watch in here (E pointed to stimulus panel) and when you see a light come on, like this (E turned on stimulus light), take your hand off the button and reach up <u>with the same hand</u> and pull this stick all the way down to the bottom—quickly.

(E allowed S to attempt twice to win a marble and rewarded both attempts. After each practice trial S was allowed to view another slide.)

Remember _________, you have to win a marble every time in order to see a picture every time. The more marbles you win, the more pictures you see. O.K.?

TABLE 1

Distribution of reinforcement (X) and nonreinforcement (0) over 48 trials for the four experimental groups

	Groups			
Trials	100 – 100	100 – 50	50 – 50	50 – 100
1	X	X	X	X
2	X	X	0	0
3	X	X	X	X
4	X	X	0	0
5	X	X	X	X
6	X	X	X	X
7	X	X	0	0
8	X	X	0	0
9	X	X	0	0
10	X	X	X	X
11	X	X	X	X
12	X	X	X	X
13	X	X	0	0
14	X	X	0	0
15	X	X	0	X
16	X	X	X	0
17	X	X	0	X

TABLE 1 (continued)

	Groups			
Trials	100 – 100	100 – 50	50 – 50	50 – 100
18	X	X	X	X
19	X	X	X	0
20	X	X	0	0
21	X	X	X	X
22	X	X	X	X
23	X	X	0	0
24	X	X	0	0
25	X	0	0	X
26	X	X	X	X
27	X	0	0	X
28	X	X	X	X
29	X	X	0	X
30	X	0	X	X
31	X	X	0	X
32	X	0	0	X
33	X	X	X	X
34	X	X	X	X
35	X	0	X	X
36	X	0	0	X

TABLE 1 (continued)

Trials	Groups: 100 - 100	100 - 50	50 - 50	50 - 100
37	X	0	0	X
38	X	0	0	X
39	X	X	X	X
40	X	0	0	X
41	X	X	X	X
42	X	0	0	X
43	X	X	X	X
44	X	X	X	X
45	X	X	X	X
46	X	0	0	X
47	X	0	0	X
48	X	X	X	X

APPENDIX B

Summaries of Analyses of Variance of Movement Speeds

TABLE 1

Summary of analysis of variance on the preshift movement speeds of groups under 50% and 100% reinforcement

Source	Sum of Squares	df	Mean Squares	F
Between Subjects (S)	120.1966	79		
A = Groups (50 or 100%)	3.8445	1	3.8445	2.621
C = Sex	1.3707	1	1.3707	0.935
AC	3.5236	1	3.5236	2.403
Ss W	111.4578	76	1.4666	
W Ss	19.0283	240		
B = Trials	5.6269	3	1.8756	36.516*
AB	1.4720	3	0.4907	9.552*
BC	0.0972	3	0.0324	0.631
ABC	0.1210	3	0.0403	0.785
B X Ss	11.7112	228	0.0514	
Total	139.2250	319		

* $p < .001$

TABLE 2

Preshift movement speeds of male and female groups under 50% and 100% reward conditions

		Trial Blocks			
		1	2	3	4
Females	50%	1.431	1.663	1.822	1.866
	100%	1.557	1.748	1.731	1.709
Males	50%	1.669	2.033	2.171	2.272
	100%	1.498	1.604	1.656	1.670

TABLE 3

Summary of analysis of variance on the preshift movement speeds of groups of males under conditions of 50% and 100% reinforcement

Source	Sum of Squares	df	Mean Squares	F
Between Subjects (S)	73.2953	39		
A = Groups (50% or 100%)	7.3646	1	7.3646	4.245*
Ss W	65.9307	38	1.7350	
W Ss	10.8437	120		
B = Trials	3.5028	3	1.1676	21.107**
AB	1.0344	3	0.3448	6.233**
B X Ss	6.3064	114	0.0553	
Total	84.1390	159		

* $p < .05$

** $p < .001$

TABLE 3

Summary of analysis of variance on the preshift movement speeds of groups of males under conditions of 50% and 100% reinforcement

Source	Sum of Squares	df	Mean Squares	F
Between Subjects (S)	73.2953	39		
A = Groups (50% or 100%)	7.3646	1	7.3646	4.245*
Ss W	65.9307	38	1.7350	
W Ss	10.8437	120		
B = Trials	3.5028	3	1.1676	21.107**
AB	1.0344	3	0.3448	6.233**
B X Ss	6.3064	114	0.0553	
Total	84.1390	159		

* $p < .05$

** $p < .001$

TABLE 4

Summary of analysis of variance of the preshift movement speeds of the four experimental groups

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	120.1966	79		
A = Groups	5.7512	3	1.9171	1.330
C = Sex	1.3707	1	1.3707	0.951
AC	9.3034	3	3.1011	2.152
Ss W	103.7713	72	1.4413	
W Ss	19.0283	240		
B = Trials	5.6269	3	1.8756	36.408*
AB	1.5946	9	0.1772	3.439**
BC	0.0972	3	0.0324	0.629
ABC	0.5820	9	0.0647	1.255
B X Ss	11.1276	216	0.0515	
Total	139.2250	319		

* $p < .001$

** $p < .005$

TABLE 5

Summary of analysis of variance of the postshift movement speeds of the four experimental groups

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	167.2842	79		
A = Groups	17.9129	3	5.9710	3.382*
C = Sex	3.8669	1	3.8669	2.190
AC	18.3851	3	6.1284	3.471*
Ss W	127.1193	72	1.7655	
W Ss	8.2798	240		
B = Trials	0.3768	3	0.1256	3.707*
AB	0.3578	9	0.0398	1.173
BC	0.1211	3	0.0404	1.192
ABC	0.1057	9	0.0117	0.347
B X Ss	7.3183	216	0.0339	
Total	175.5640	319		

* $p < .025$

TABLE 6

Summary of analysis of variance of the postshift movement speeds of male subjects according to preshift and postshift reinforcement conditions

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	118.7983	39		
A = Preshift (50% or 100%)	14.3742	1	14.3742	6.263*
C = Postshift (50% or 100%)	21.3299	1	21.3299	9.294**
AC	0.4738	1	0.4738	0.206
Ss W	82.6204	36	2.2950	
W Ss	4.7186	120		
B = Trials	0.3456	3	0.1152	3.060***
AB	0.0800	3	0.0267	0.708
BC	0.2169	3	0.0723	1.921
ABC	0.0100	3	0.0033	0.089
B X Ss	4.0660	108	0.0376	
Total	123.5169	159		

* $p < .025$

** $p < .005$

*** $p < .05$

TABLE 7

Summary of analysis of variance of the postshift movement speeds of female subjects according to preshift and postshift reinforcement conditions

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	44.6190	39		
A = Preshift (50% or 100%)	0.0545	1	0.0545	0.044
C = Postshift (50% or 100%)	0.0628	1	0.0628	0.051
AC	0.0027	1	0.0027	0.002
Ss W	44.4989	36	1.2361	
W Ss	3.5612	120		
B = Trials	0.1524	3	0.0508	1.683
AB	0.0063	3	0.0021	0.070
BC	0.1240	3	0.0413	1.373
ABC	0.0262	3	0.0087	0.290
B X Ss	3.2522	108	0.0301	
Total	48.1802	159		

TABLE 8

Summary of analysis of variance of the postshift movement speeds of male subjects in groups 50 - 50 and 50 - 100

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	66.3942	19		
A = Groups 50 - 50 or 50 - 100	14.0809	1	14.0809	4.845*
Ss W	52.3133	18	2.9063	
W Ss	2.7761	60		
B = Trials	0.0782	3	0.0261	0.546
AB	0.1184	3	0.395	0.826
B X Ss	2.5795	54	0.0478	
Total	69.1703	79		

* $p < .05$

TABLE 9

Summary of analysis of variance of the postshift movement speeds of male subjects in groups 100 - 100 and 100 - 50

Source	Sums of Squares	df	Mean Squares	F
Between Subjects (S)	38.0298	19		
A = Groups 100 - 100 and 100 - 50	7.7228	1	7.7228	4.587*
Ss W	30.3071	18	1.6837	
W Ss	1.9425	60		
B = Trials	0.3473	3	0.1158	4.206**
AB	0.1086	3	0.0362	1.315
B X Ss	1.4865	54	0.0275	
Total	39.9723	79		

* $p < .05$

** $p < .01$

APPENDIX C

Summary Tables of Analyses of Variance of Reaction and Starting Speeds

TABLE 1

Summary of analysis of variance of the preshift reaction speeds of groups receiving 50% and 100% reinforcement

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	74.3965	79		
A = Groups (50% or 100%)	0.1071	1	0.1071	0.114
C = Sex	2.2211	1	2.2211	2.362
AC	0.6066	1	0.6066	0.645
Ss W	71.4618	76	0.9403	
W Ss	35.1277	240		
B = Trials	6.4061	3	2.1354	17.910*
AB	0.5436	3	0.1812	1.520
BC	0.8777	3	0.2926	2.454
ABC	0.1158	3	0.0386	0.324
B X Ss	27.1844	228	0.1192	
Total	109.5242	319		

* $p < .001$

TABLE 2

Summary of analysis of variance of the preshift starting speeds of groups receiving 50% and 100% reinforcement

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	81.6944	79		
A = Groups (50% or 100%)	1.3139	1	1.3139	1.291
C = Sex	3.0165	1	3.0165	2.963
AC	0.0045	1	0.0045	0.004
Ss W	77.3595	76	1.0179	
W Ss	16.5871	240		
B = Trials	3.7968	3	1.2656	23.920*
AB	0.3227	3	0.1076	2.033
BC	0.1008	3	0.0336	0.635
ABC	0.3034	3	0.1011	1.912
B X Ss	12.0635	228	0.0529	
Total	98.2815	319		

* $p < .001$

TABLE 3

Summary of analysis of variance of the preshift reaction speeds of the four experimental groups

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	74.3965	79		
A = Groups	1.1862	3	0.3954	0.407
C = Sex	2.2211	1	2.2211	2.287
AC	1.0737	3	0.3579	0.369
Ss W	69.9156	72	0.9710	
W Ss	35.1277	240		
B = Trials	6.4061	3	2.1354	17.654*
AB	1.0790	9	0.1199	0.991
BC	0.8777	3	0.2926	2.419
ABC	0.6379	9	0.0709	0.586
B X Ss	26.1269	216	0.1210	
Total	109.5242	319		

* $p < .001$

TABLE 4

Summary of analysis of variance of the postshift reaction speeds of the four experimental groups

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	93.5780	79		
A = Groups	2.9766	3	0.9922	0.849
C = Sex	1.2836	1	1.2836	1.098
AC	5.1272	3	1.7091	1.462
Ss W	84.1906	72	1.1693	
W Ss	15.8986	240		
B = Trials	0.1765	3	0.0588	0.944
AB	1.0973	9	0.1219	1.956*
BC	0.1907	3	0.0636	1.020
AB C	0.9704	9	0.1078	1.730
B X Ss	13.4637	216	0.0623	
Total	109.4766	319		

* $\underline{p} < .05$

TABLE 5

Summary of analysis of variance of the preshift starting speeds of the four experimental groups

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	81.6944	79		
A = Groups	1.5411	3	0.5137	0.515
C = Sex	3.0165	1	3.0165	3.027
AC	5.3794	3	1.7931	1.799
Ss W	71.7574	72	0.9966	
W Ss	16.5871	240		
B = Trials	3.7968	3	1.2656	23.717*
AB	0.5310	9	0.0590	1.106
BC	0.1008	3	0.0336	0.629
ABC	0.6322	9	0.0702	1.316
B X Ss	11.5264	216	0.0534	
Total	98.2815	319		

* $p < .001$

TABLE 6

Summary of analysis of variance of the postshift starting speeds of the four experimental groups

Source	Sums of Squares	df	Means Squared	F
Between Subjects (S)	111.1571	79		
A = Groups	4.3951	3	1.4650	1.061
C = Sex	1.9818	1	1.9818	1.435
AC	5.3276	3	1.7759	1.286
Ss W	99.4525	72	1.3813	
W Ss	8.2059	240		
B = Trials	0.0489	3	0.0163	0.486
AB	0.4668	9	0.0519	1.546
BC	0.0571	3	0.0190	0.567
ABC	0.3872	9	0.0430	1.282
B X Ss	7.2460	216	0.0335	
Total	119.3630	319		

APPENDIX D

Mean Reaction, Starting and Movement Speeds of Males and Females of the Four Experimental Groups Over Preshift and Postshift Trial Blocks

TABLE 1

Mean reaction speeds of males and females of the four experimental groups over preshift and postshift trial blocks

			Trial Blocks			
Phase	Sex	Groups	1	2	3	4
	F	50 - 50	1.494	1.543	1.683	1.758
	F	50 - 100	1.420	1.642	1.864	1.921
Preshift	F	100 - 100	1.812	1.875	1.826	2.055
	F	100 - 50	1.628	1.637	1.619	1.863
	M	50 - 50	1.708	1.840	2.180	2.164
	M	50 - 100	1.480	2.017	2.048	1.919
Preshift	M	100 - 100	1.698	1.818	2.030	2.174
	M	100 - 50	1.527	1.862	1.943	1.899

			Trial Blocks			
Phase	Sex	Groups	7	8	9	10
	F	50 - 50	1.842	2.054	1.865	2.022
	F	50 - 100	2.208	2.044	2.236	1.932
Postshift	F	100 - 100	2.095	1.937	2.034	2.075
	F	100 - 50	1.930	1.867	2.116	1.939
	M	50 - 50	2.491	2.510	2.465	2.566
	M	50 - 100	2.000	2.169	1.957	2.029
Postshift	M	100 - 100	1.981	1.937	2.204	2.079
	M	100 - 50	1.905	1.875	1.973	2.081

TABLE 2

Mean starting speeds of males and females of the four experimental groups over preshift and postshift trial blocks

Phase	Sex	Groups	Trial Blocks 1	2	3	4
Preshift	F	50 - 50	1.412	1.594	1.773	1.823
	F	50 - 100	1.689	1.889	2.098	2.195
	F	100 - 100	1.478	1.618	1.633	1.800
	F	100 - 50	1.686	1.787	1.710	1.796
Preshift	M	50 - 50	1.975	2.204	2.261	2.421
	M	50 - 100	1.729	1.816	1.839	1.842
	M	100 - 100	1.755	1.829	1.929	1.973
	M	100 - 50	1.693	1.930	1.973	1.919

Phase	Sex	Groups	Trial Blocks 7	8	9	10
Postshift	F	50 - 50	1.880	1.819	1.790	1.916
	F	50 - 100	2.107	2.091	1.914	1.914
	F	100 - 100	1.781	1.810	1.855	1.803
	F	100 - 50	1.836	1.942	2.009	2.022
Postshift	M	50 - 50	2.398	2.414	2.487	2.408
	M	50 - 100	1.843	1.924	1.878	1.961
	M	100 - 100	1.843	1.798	1.851	1.789
	M	100 - 50	2.026	2.084	2.135	2.166

TABLE 3

Mean movement speeds of males and females of the four experimental groups over preshift and postshift trial blocks

Phase	Sex	Groups	Trial Blocks 1	2	3	4
Preshift	F	50 - 50	1.434	1.626	1.721	1.823
	F	50 - 100	1.428	1.699	1.923	1.910
	F	100 - 100	1.587	1.849	1.833	1.855
	F	100 - 50	1.527	1.646	1.629	1.563
Preshift	M	50 - 50	1.839	2.265	2.471	2.607
	M	50 - 100	1.499	1.801	1.870	1.939
	M	100 - 100	1.378	1.472	1.525	1.520
	M	100 - 50	1.617	1.736	1.788	1.820

Phase	Sex	Groups	Trial Blocks 7	8	9	10
Postshift	F	50 - 50	1.742	1.831	1.783	1.868
	F	50 - 100	1.850	1.914	1.778	1.806
	F	100 - 100	1.791	1.856	1.805	1.783
	F	100 - 50	1.726	1.777	1.713	1.826
Postshift	M	50 - 50	2.636	2.767	2.754	2.811
	M	50 - 100	1.924	1.923	1.859	1.907
	M	100 - 100	1.402	1.363	1.394	1.491
	M	100 - 50	1.899	2.037	2.030	2.169